

Driving TEAM Remotely

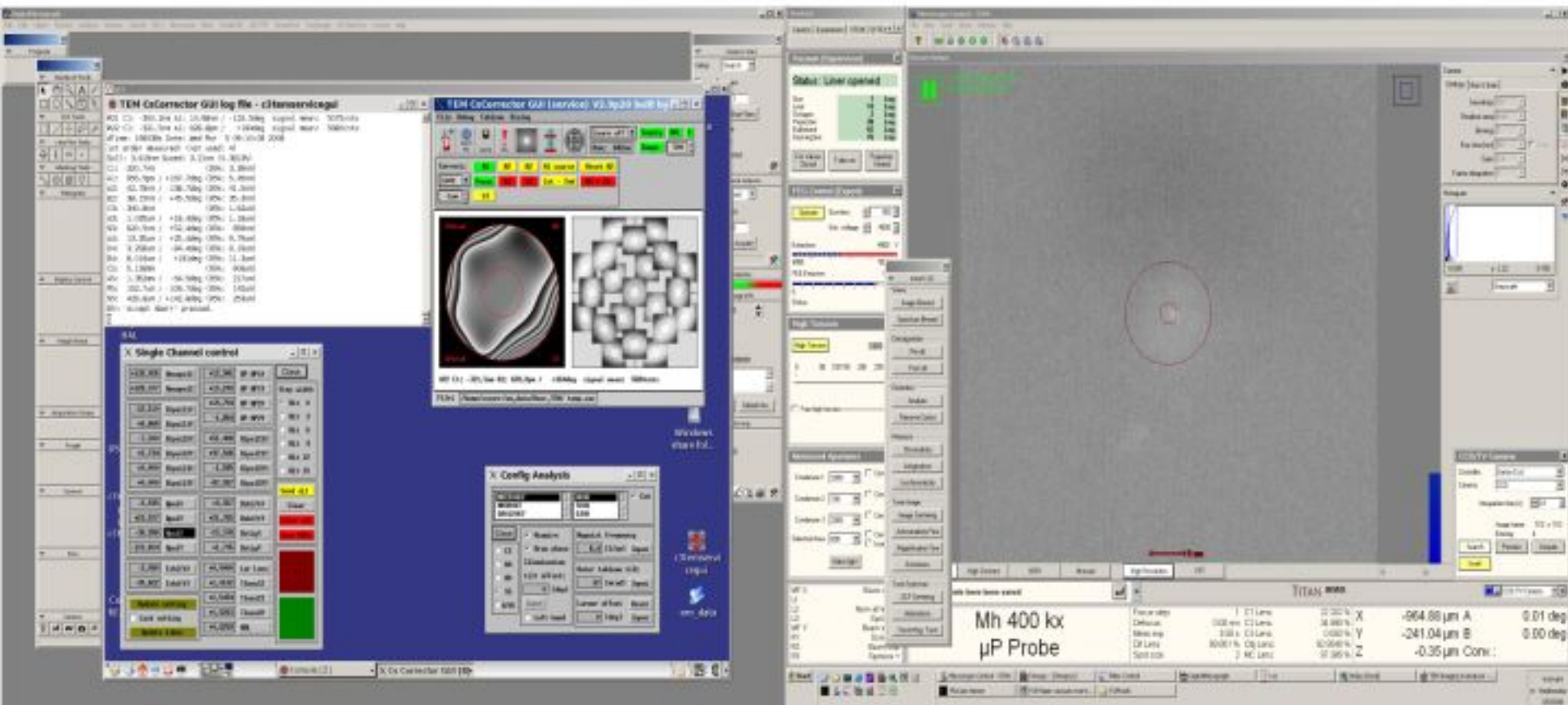
Operation, Alignments, Feasibility

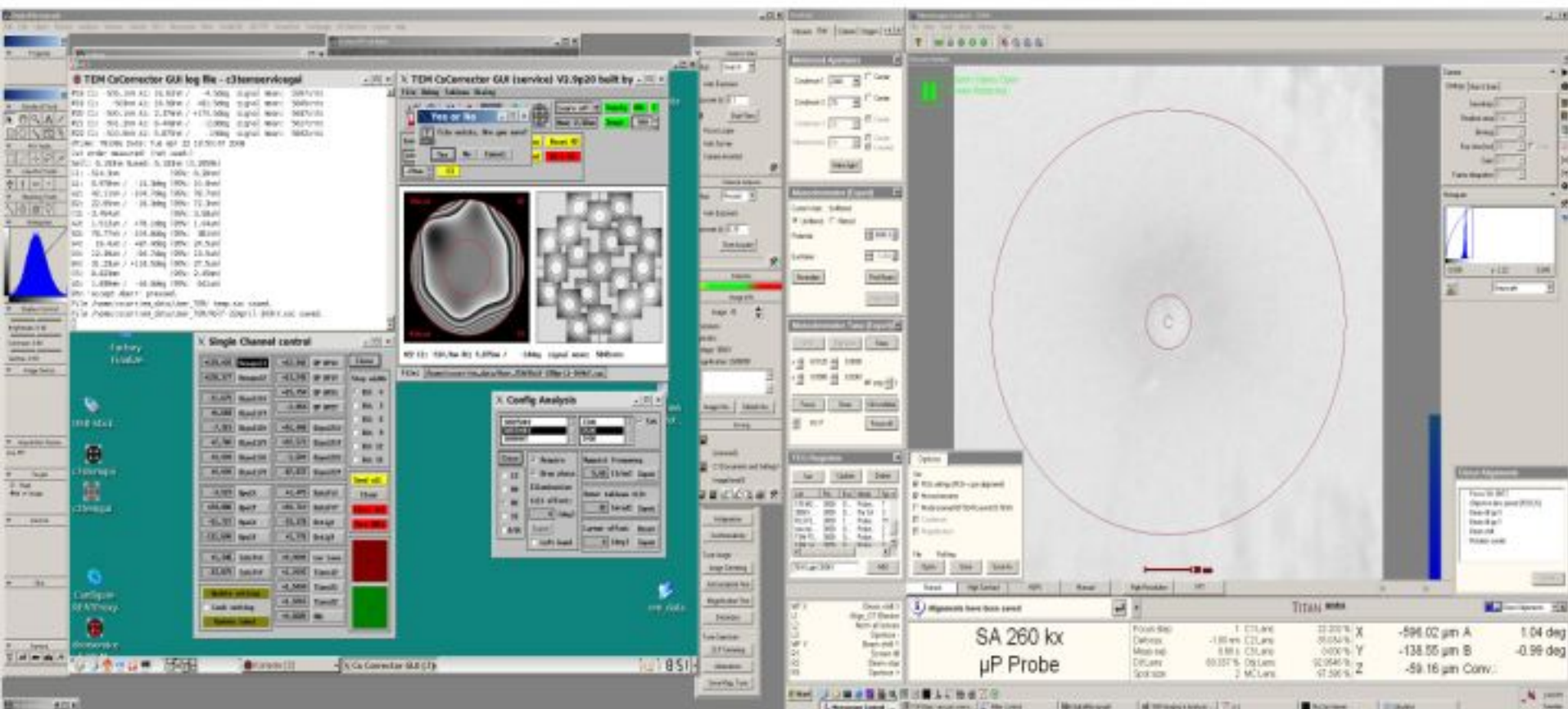
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Potential for Remote Control



The TEAM0.5 and TEAM1 microscopes are operated remotely, but “in-house”.





Microscope user needs to have access to ~6 different Graphical User Interfaces (GUIs)
Windows XP PC

1. **FEI Titan software**: basic microscope control software
2. **FEI TIA**: CCD, STEM, EELS, "movies"
3. **Gatan DigitalMicrograph**: CCD, EFTEM, EELS, image processing
4. **FEI FluCam**: beam control and manual microscope alignments
5. **CEOS aberration-corrector software** (Linux ... Windows)
6. **Gatan FilterControl** (no GUI necessary)
7. **Vacuum software, TEMSpy, FEISpy,...**

2 (or more?) possibilities for a remote system:

- *Making use of the "normal" microscope GUI – exported to a remote PC*
- *Replace all software with a new dedicated remote-control software*

Currently there are ~6 programs needed to "operate" the microscope.

_ Tasks can be carried out in more than just one way.

_ **Simplifying the GUI(s)** = merging the entire functionality in one GUI.

Requirements of the remote GUI

- Needs to provide equivalent functionality: 100%!
- Needs to have the equivalent interlocks and safety features
- On-site access has always priority, all remote changes need to be 100% reversible
- NCEM needs to see what's done remotely (up-to-date history)
- Needs to be very similar to the on-site microscope control
(remote users are trained on the actual microscope... preventing additional training)

The Knob Problem

The difference between a normal office space and a microscope control room: Knobs.



Having a fully software controlled microscope...

Why do we need manual control panels and knobs?

Implementing the functionality of the control panels into the software (... it's already there)

- Makes any office space to a potential microscope control room
- Makes remote systems cheaper

The demands on users increase with the distance to the instrument.

The user

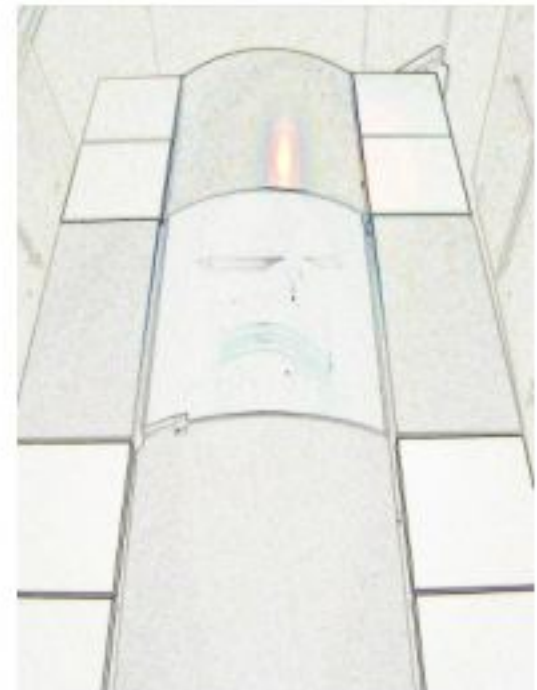
- Needs to know in detail the software and its functionality
- Needs to rely on the software and on the proper functioning of the hardware
- In case of a problem, needs to be able to judge where something could have gone wrong



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←→

Locating the problem



User = Somebody who makes use of NCEM's microscope facility

A) Remote Observer

Remote user observes and "commands" actions on microscope.

Multi-user session.

B) Remote Controller

Remote user directs, controls and finishes a measurement that was set-up and started by a non-remote operator.

C) Remote Operator

Remote user runs measurements fully remotely, by her-/himself.

"No" support. Remote user performs, e.g., follow-up measurements.

A) Remote Observer

Remote user observes and commands actions on microscope.

Multi-user session.

- cheapest "remote" solution – exported GUI, no hardware
- saves the time of training (for trainee AND trainer)
- saves travel expenses
- requires a certain degree of collaboration
- ideal if more than two parties are involved, results can be discussed while running experiments

Most suitable for infrequent, one-time or first-time users.

B) Remote Controller

*Remote user controls and finishes a measurement that was started by a non-remote operator.
On-site guidance and support needed – start-up and finish, advice etc.*

- the functionality of the remote system can be mini- or optimized
(e.g. only software interface, no hardware panels etc.)
- reduces the risk of getting lost in the measurement and/or "misaligning" the instrument
- after a rather short training (a few days), remote results are feasible
- saves travel expenses, and some training time

Suitable for frequent users with limited experience.

If the remote GUI is largely different from the on-site GUI, additional training is needed.

C) Remote Operator

Remote user performs, e.g., follow-up measurements.

Remote user conducts measurements fully remotely by her-/himself.

- the *functionality* of the remote system has to be **equivalent** to the on-site control room
- **additional** *functionality* needed for operation and safety, e.g., webcam of the microscope and stage
- extended training necessary
- only minimal support is needed: sample change (in current configuration)
- saves travel expenses
- depending on the level of user, definition of different "playgrounds" might be necessary (software)

Suitable for very experienced users only.

If the remote GUI is largely different from the on-site GUI, additional training is needed.

A typical microscope session

- Check status of the microscope (mode, vacuum, gun, high tension etc.) 5 min
- Insert an alignment specimen 30 min
- Select operation mode and do necessary manual microscope alignments 30 min
- Measure residual aberrations and perform fine tuning of the aberration corrector(s) 60 min
- Prepare specimen; mounting, plasma cleaning, heat plate... 15 min
- Change holder, load holder with specimen of interest 30 min
- **Run experiments** while keeping microscope aligned ? min
- Remove sample, make system ready for next user 20 min
- Copy data (memory stick, DVD etc.) 30 min

Check status of the microscope.

Insert an alignment specimen.

Select operation mode and do necessary manual alignments

Tuning of the aberration corrector(s)

Change specimen, load holder with specimen of interest

Run experiments and manual fine (re-)tuning of the alignment

Remove sample, make system ready for next user

Copy data (memory stick, DVD etc.)

Observer, Controller, Operator

Not feasible

(Controller), Operator,

Operator

Not feasible

Controller, Operator

Not feasible

OK (depends on connection)

Sample change is the only operation that cannot be performed remotely!

Sample change is needed to align the corrector(s).

Is a 100% remote session possible? NO.

Is a remote session with limited support possible? YES.



What's the most efficient way of dealing with (expensive) microscope time?

- Remote control should aim at **gaining (useful) microscope time**
- Preparation and clean-up time before and after remote sessions should be short
- Minimize additional "remote-control" training
- Remote control must not lead to additional down-time (interlocks, safety etc.)

Remote control can increase the microscope time and save travel burden.

TEAM 0.5 (& TEAM 1) is suitable for remote control

- apart from sample change, all tasks can be performed by software control
- limited NCEM support is needed in any case, independent of how trained the user is

Simplified GUI is desirable – replacing hardware control panels

Remote control complicates the operation – it doesn't make it easier.
the complexity increases with the distance to the instrument

Case-specific type of remote access

observer, controller, operator

